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Ahead of the Storm
New Ideas in Flood Protection

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Weather-related flooding of homes in Texas is nothing new. Hurricanes and other heavy rainfall events have been damaging residential properties for decades. However, Hurricane Harvey's unprecedented 50-plus inches of rain heightened many homeowners' concerns about their vulnerability to flooding.

In addition, strong population growth has led to more housing in low-lying and coastal areas of the state. As a result, home flooding has become more commonplace in Texas.

To reduce the chances of flood-related damage, potential new-home buyers can familiarize themselves with effective flood-resistant techniques and products before construction begins when implementation cost is lowest. Existing homeowners can benefit from discovering what methods and products are most effective in protecting their current residence against flooding.

Changes in residential construction materials and techniques occur slowly. Builders have little incentive to use advanced materials or methods to reduce flood damage if they feel no pressure from homebuyers or the government to do so. Adoption will occur much faster if it is demand-driven by informed consumers.

The Takeaway

Population growth has pushed housing development into more flood-prone areas of the state. New products and methods can help residents in these areas protect their homes against floodwaters and minimize damage caused by hurricanes and other severe weather events.

Governor's Hard Look at Disaster Preparation

Eye of the Storm, a report by the Governor's Commission to Rebuild Texas, was published in November 2018. The report recommended ways Texas can be better prepared for disasters. It's available online at www.rebuildtexas.today.

A key strategy to avoid flooding involves establishing statewide standards or best practices to elevate structures above the base flood elevation (BFE) in flood-prone areas. Currently, Texas has no statewide standards.

BFE is defined as the elevation shown on the Flood Insurance Rate Maps for floodzones A and V inside the 100-year floodzone, an area with a 1 percent chance of a flood occurrence in any given year. The 100-year flood patterns help determine the National Flood Insurance Program (NFIP) rates for homeowners purchasing flood insurance. Zones A and V are in a Special Flood Hazard Area (SFHA). Homes with a federally backed mortgage that are in an SFHA must purchase flood insurance.

If the Federal Emergency Management Agency (FEMA) provides a community with the flood hazard information that floodplain management regulations are based on, the community can adopt its own "model" floodplain management ordinance that best fits its particular flood risks. The ordinance must meet or exceed minimum NFIP standards. At that point, the community becomes responsible for floodplain management inside its corporate limits.

Texas has no statewide model or best-practice ordinance. However, many communities have concluded that homes elevated up to the BFE are not sufficiently protected from flooding. The BFE does not account for the impacts of future development, increasing rainfall, subsidence, or rising sea levels. The report states that flooding above BFE is already fairly common in Texas.

Weathering the Storm Through Innovative Thinking

The U.S. Department of Energy's Solar Decathlon is a biennial collegiate competition that challenges student teams to design and build highly efficient and innovative structures. Stevens Institute of Technology's SURE House was the 2015 award winner.

In the wake of Hurricane Sandy, the Stevens team's goal was to design a hurricane-proof home for a middle-class family with flexible, energy-efficient living space that would provide comfortable living in a mere 1,000 square feet.

The team initially studied prior coastal construction methods to identify which had been successful and which had been prone to storm damage. To construct the home, the team then combined state-of-the-art building science, the latest solar energy technologies, and fiber-composite materials repurposed from the boat-building industry.

The house was designed to be positioned so that storm shutters on the south-facing side act as shade and provide solar power from integrated solar panels when raised. When locked down, they act as a watertight seal during hurricanes and floods. The shutters also provide a defensive barrier that protects the home from debris.

Thin, flexible, marine-grade, plastic, solar photovoltaic panels are extremely lightweight, allowing a homeowner to easily raise and lower the shutters manually. The panels have much greater impact resistance than glass to prevent damage when struck by debris.

A waterproof composite sheathing was applied to the bottom and sides of the home. The result was a structure rated to withstand up to six feet of floodwater against the exterior.

Currently, FEMA does not allow dry floodproofing in residential applications below BFE. "Dry floodproofing is only code-approved for commercial buildings," said project engineer Christine Hecker. "However, we built the house as an exhibition in how FEMA could allow it in residential applications while still maintaining safety."

Most of the construction was completed using standard building materials. The main exception was the storm shutters, which were custom-designed and built by the team as a research project. "The shutters would have to be specially designed and built by a fiberglass composite builder," said Hecker. "Most of the construction other than the storm shutters can be found off the shelf."

The Stevens team had the assistance of GURIT Engineering's marine division and the International Yacht Restoration School in the construction of the shutters. Students completed the home's flood modeling at the Stevens Institute of Technology's Davidson marine research laboratory. SURE House is currently on exhibit at the Liberty Science Center in Jersey City, N.J.

Additional elevation is usually expressed as "freeboard," the number of feet the first inhabited floor of a building is above the BFE. A freeboard requirement is meant to provide an extra margin of protection that accounts for waves, debris, changing future weather conditions, new development, and a lack of accurate data. Individual communities can adopt their own freeboard requirements.

A national study by two professors, Wes Highfield and Sam Brody of Texas A&M University at Galveston, found freeboard requirements to be the most effective of all mitigation strategies in terms of avoiding flood damage to residential structures. Elevating structures above the BFE can significantly lower homeowners' federal flood insurance rates.

Ways Homeowners Can Address Potential Flooding

In another study published in 2017, Brody, Highfield, and Yoonjeong Lee (also of Texas A&M University at Galveston) surveyed coastal residents in parts of Texas and Florida. Results showed household actions to reduce flooding included a variety of activities and costs. Three primary categories of residential flood mitigation techniques were defined based on the expense, time, and amount of effort involved.

The least-expensive flood mitigation involves simply gathering and exchanging helpful information about the purchase of flood insurance, contacting different agencies for flood-hazard information, and attending meetings to discuss local flood hazards.

The next level of mitigation entails "wet floodproofing" a home. With wet floodproofing, permanent or contingent measures are put in place to resist, not prevent, flood damage. Uninhabited portions of a home, such as crawlspaces or first floors used for parking or storage, are constructed or modified to allow floodwaters to enter and exit. Flood-resistant materials are used below the BFE along with vents or breakaway walls. In addition, measures are taken to protect utility systems.

The highest level of mitigation involves the most time and greatest expense. Major changes are required, such as elevating the entire house or adding a new floor, erecting an earthen barrier or berm around the home, or "dry floodproofing" exterior walls and doors.

Dry floodproofing involves making a home watertight below the level that needs flood protection. This requires sealing the walls with some type of waterproof coat-

Buoyant Solution to Home Flooding

FloodFrame is a Danish company that opened its first U.S. location in Houston in 2019. Their product is an exterior flood-protection system concealed around the perimeter of a home. The system is buoyant, using the weight of water to move it into position. No electrical power is needed for its deployment.

A waterproof cloth is rolled around a lightweight pipe custom-fitted to the home's measurements. The cloth is placed in a pre-installed concrete box typically located about six inches from the home's exterior walls on top of an inflatable plastic tube. As floodwaters rise, the plastic tube is inflated, lifting the cloth out of the box and onto the ground. Manual deployment is also an option. The force of rising water pushes, unfolds, and rolls the cloth toward and up the wall of the home.

The system can be tailored to protect at almost any water level the homeowner chooses. However, a typical house can withstand water to a height of about three feet before the walls are at risk for structural damage.

"In fast-rising water, the system can deploy within seconds," according to Tasha Nielsen, FloodFrame's vice-president of development. "If floodwater reaches the box before the cloth is fully on the ground, the water simply helps to push the cloth out of the box."

The system is designed so rainfall cannot come between the barrier and the home, since the cloth is pressed firmly against the walls by the surface water. The auto-release system deploying the cloth will be activated when the sensor is flooded from below by surface water.

Raising the Standard in Modular Home Flood Prevention

GroundFORCE Building Systems of Navasota, Texas, manufactures unique modular homes that use a high-strength concrete flooring system rather than traditional wood framing. Modules can also be constructed to Leadership in Energy and Environmental Design standards.

The structurally suspended concrete floor is designed to virtually eliminate foundation damage common with traditional foundation systems. Base thickness of a module's engineered perimeter beams averages 20 to 22 inches in height. A typical module is 40 feet in length.

Modules are delivered using the company's patented delivery method, traveling only a few inches above the ground. The method allows modules with ten-foot ceiling heights to clear overpasses when being transported.

On location, corner piers are drilled, modules are placed in position via the transport rig (eliminating the need for an expensive crane) and affixed to the piers. Multiple modules can be used to create any size house desired. Elevations can be as high as homeowners specify. Every pier plan is engineered for the given site and soil situation.

The design requires only a center pier and one pier at each corner of a module. In residential applications, modular units meet all International Residential Code requirements. Financing and appraisal of the modular homes is no different than for a site-built home.

Installing and finishing a home on location takes an average of about one week. A two-section house can often be completed in as little as three to four days.

Homes can be moved multiple times while still maintaining structural integrity. Piers can also be extended in height after installation much more inexpensively than raising a traditional home.

"The time and money that can be saved to relocate or increase the elevation of a home gives us a huge advantage over site-built houses," said GroundFORCE CEO Kenneth Neatherlin.

ing or impermeable membrane. Floodproof doors and windows are sealed as well.

FEMA states that "dry floodproofing may not be used to bring a substantially damaged or substantially improved residential structure into compliance with the community's floodplain management ordinance or law." However, new innovations and construction methods have been used to test the viability of dry floodproofing a home.

Brody, Highfield, and Lee contended that some homeowners who were informed and aware of their flood risks may have already decided to locate outside of flood zones or at higher elevations. The study concluded survey respondents as a whole were typically not aware of the actual flood risk to their properties.

Educated Consumers, Informed Decisions

An extensive investigation of all the methods and technologies currently available to protect against flooding is impractical. Three are discussed in the sidebars "Buoyant Solution to Home Flooding," "Raising the Standard in Modular Home Flood Prevention," and "Weathering the Storm Through Innovative Thinking."

Unfortunately, the frequency, timing, and severity of future flooding at a specific location cannot be predicted. Hurricane Harvey proved that, under the right conditions, areas thought to be safe from flooding may not be. As a result, homeowners should ask questions and carefully consider their options before spending money on flood-protection upgrades.

Each homeowner has a unique financial situation and level of risk aversion. If funds are available, how much should be spent on flood protection? Will the potential benefit exceed the cost?

A traditional "payback period" calculation may not be appropriate when there is no way to know if flood-protection measures will ever be needed. Will money spent on flood protection add to the home's market value? Does it matter if no value is added?

Would it be better and more cost effective to just relocate to a higher elevation? This option may not be available to low-income families living in vulnerable areas.

At the basic level, becoming better educated on flood protection merely requires an expenditure of time and energy, not money. When money is required, a significant degree of thought and self-evaluation is essential before making any final decisions.

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For More Information

***Eye of the Storm* (169-page Governor's Report)**

https://www.rebuildtexas.today/wp-content/uploads/sites/52/2018/12/12-11-18-EYE-OF-THE-STORM-digital.pdf

National Flood Insurance Program (NFIP) Glossary and Basic Explanations

http://wetlandswatch.org/national-flood-insurance-program-glossary-and-basic-explanations

Flood Insurance Basics

https://www.floodsmart.gov/

http://flash.org/peril_inside.php?id=56

Flood Insurance Rate Maps (FIRMs)

https://www.floodsmart.gov/why/all-about-flood-maps

Wet Floodproofing Discussions (FEMA)

https://www.fema.gov/media-library-data/20130726-1608-20490-7205/fema551_ch_06.pdf

https://articles.extension.org/pages/13865/techniques-for-wet-floodproofing

Dry Floodproofing Discussions (FEMA)

https://www.fema.gov/media-library-data/06dabddadc3887f91906172d863749ab/P-936_sec3_508.pdf

https://www.fema.gov/media-library-data/20130726-1608-20490-9182/fema_551_ch_07.pdf

https://articles.extension.org/pages/13853/techniques-for-dry-floodproofing

Reducing Flood Risk to Residential Buildings That Cannot Be Elevated (FEMA)

https://www.fema.gov/media-library-data/1443014398612-a4dfc0f86711bc72434b82c4b100a677/revFEMA_HMA_Grants_4pg_2015_508.pdf

The SURE House

https://surehouse.org/the-house/

https://www.solardecathlon.gov/2015/competition-team-stevens.html

FloodFrame Technology

https://floodframe.com/us/

https://www.youtube.com/watch?v=yZkMEMjzSIU

GroundForce Building Systems

https://www.groundforce.com/

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